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REVISED NORMATIVE STANDARDS OF PERFORMANCE OF MEN ON A QUANTITATIVE ATAXIA TEST BATTERY

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NAVAL AEROSPACE MEDICAL RESEARCH LABORATORY
PENSACOLA FLORIDA

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SUMMARY PAGE

THE PROBLEM

To revise normative standards of performance of men, ages 16-60 years, on a quantitative ataxia test battery in terms of new chronological age groupings based on a sample of 1055 normal men.

FINDINGS

Highly significant relationships in ataxia test battery scores were found with age, spanning 16 to 60 years of age. All subtests of the battery, except Walk On Floor Eyes Closed (WOFEC) test, were very nearly similar in sensitivity to aging influences, implying a reliably unitary sensitivity of the battery to aging influences on the complex postural equilibrium functions sampled by it.

Present findings tentatively suggest that the negative aging influences become apparent several years earlier than reported previously (within the age range of 31-40 years rather than 43-50 years). The progressive nature of this aging influence along the life span sampled is similar to that previously reported on women.

The new normative standards presented should allow more precise laboratory and clinical applications of the test battery which has proved to be useful particularly in the vestibular physiological and neuro-otological assessment of postural equilibrium-disequilibrium, including spontaneous and induced vestibular ataxia. The test battery has other clinical and/or research applications.

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13. ABSTRACT

Revised normative standards of performance of men, ages 16-60 years, on a quantitative ataxia test battery in terms of new chronological age groupings based on a sample of 1055 normal men are presented. Five age groups--16-30, 31-40, 41-45, 46-50, and 51-60 years--were found to be required to reduce the correlation with age to a nonsignificant level. All subtests of the battery, except Walk On Floor Eyes Closed (WOFEC), were very nearly similar in sensitivity to aging influences, implying a reliably unitary sensitivity of the battery to aging influences on the complex postural equilibrium functions sampled by it. Present findings tentatively suggest that the negative aging influences become apparent several years earlier than reported previously (within the age range of 31-40 years rather than 43-50 years). The progressive nature of this aging influence along the life span sampled is similar to that previously reported on women. The new normative standards should allow more precise laboratory and clinical applications of the test battery which has proved to be useful particularly in the vestibular physiological and neuro-otological assessment of postural equilibrium-disequilibrium, including spontaneous and induced vestibular ataxia. The test battery has other clinical and/or research applications.

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INTRODUCTION

Several years ago age-influenced normative standards of performance on a new quantitative ataxia test battery designed initially for assessment of vestibular ataxia (1,7)* were published (2,7). To control for the observed negative influence of chronological aging on scores, the normative standards were presented in relation to several chronological age groupings. Meanwhile, many additional individuals--almost entirely men--were tested, and new indications of aging influences on test scores came to light. Accordingly, normative standards were revised in terms of new chronological age groupings, incorporating the additional samples of normal men tested and new 5th percentile and below cut-off scores relative to an arbitrary definition of frank ataxia (3,4). This up-dated information is presented and discussed to allow more precise laboratory and clinical applications of the test battery.

PROCEDURE

SUBJECTS

The sample of 1055 normal men, 16 to 60 years of age, included all those physically fit† who had been tested since standardization of the short version of the "rail battery" and the "floor battery" of ataxia tests (1,4,7). Occupational groups included experienced and student military and civilian aviators, Army and Navy enlisted and civilian college student volunteer research subjects; Navy deep-sea divers; and miscellaneous active and retired military and civilian scientific, medical, engineering, aviation, and technical personnel.

METHOD

Because detailed administration and scoring procedures have been published previously (1,2,4,7), these tests are described only briefly below. All tests were undertaken while subjects wore hard-soled shoes and were in the stringent position of arms folded against chest, feet aligned heel-to-toe (tandemly), with the exception of the Stand One Leg Eyes Closed tests, and body erect or nearly erect. Administered in the following order, they consisted of the:

1. Sharpened Romberg (SR): standing on the floor with eyes closed for 60 seconds. Maximum score obtainable: 240 seconds.

2. Walk Eyes Open (Walk E/O): walking 5 steps per trial on a 3/4-inch-wide by 8-foot-long rail. Maximum score obtainable: 15 steps.

3. Stand Eyes Open (Stand E/O): standing on the 3/4-inch-wide rail for a maximum of 60 seconds per trial. Maximum score obtainable: 180 seconds.

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* The items of the battery are also known as tests of postural equilibrium-disequilibrium (7).

† All had undergone a comprehensive medical and audiological evaluation. The very great majority also had benefit of a comprehensive vestibular evaluation.

4. Stand Eyes Closed (Stand E/C): standing on a 2-1/4-inch-wide by 30-inch-long rail for a maximum of 60 seconds per trial. Maximum score obtainable: 180 seconds.

5. and 6. Stand One Leg Eyes Closed (SOLEC-R and SOLEC-L): standing stationary on the floor on each leg for a maximum of 30 seconds on any trial. Maximum score obtainable: 150 seconds on each leg.

7. Walk On Floor Eyes Closed (WOFEC): walking in the stringent position described above for a maximum of 10 steps per trial. Maximum score obtainable: 30 steps.

This battery of ataxia tests evolved in stages. Whereas all subjects undertook the "rail battery" and the SR test, as noted above, a smaller number also undertook the SOLEC tests (N = 749), and fewer still also undertook the WOFEC (N = 287).

RESULTS

CHRONOLOGICAL AGE INFLUENCES ON ATAXIA TEST BATTERY SCORES

To control for the negative influences of chronological aging on performance it was necessary to demonstrate a nonsignificant correlation between chronological age and scores on each of the test battery items within each of several age groupings. Five age groups were found to be required to accomplish this end as shown in Table I. The mean ataxia test scores within each new chronological grouping are plotted in Figure 1*. It may be seen in Table I that in the total group of subjects tested (16-60 year olds), all correlations between chronological age and subtest scores were highly significant, whereas none of the consistently lower correlations within the five subgroups were statistically significant.

REVISED ATAXIA TEST BATTERY NORMATIVE STANDARDS

Mean ataxia test battery subtest scores and standard deviations, and the raw scores and their percentile equivalents for each of the five new chronological age groupings are shown in Tables II to VII. Included in each table are the mean ages and standard deviations. For the convenience of users of the ataxia test battery, the recently published WOFEC test norms (4) are reproduced in form similar to the above in Table VIII. Also for convenience sake, all scores arbitrarily defined as "ataxic" (3,4), i.e., all 5th percentile and below cut-off scores (4th percentile and below for WOFEC) on each ataxia test battery item for each of the five chronological age groupings, are set off by a line between the 10th and 5th percentile in Tables II to VII.

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*WOFEC scores by ages are not included because of their very low and not statistically significant correlation (r = -.06) with age (17-61 year old men) (4).

It should be emphasized, as reported previously (3,4), that, whereas a raw score having a 5th percentile, or below, equivalent has been defined as an ataxic test score, an individual is considered by us to be frankly ataxic (4) only when scores on all items of the battery performed with eyes closed (Stand E/C, SR, SOLEC-R and SOLEC-L, and WOFEC) fall at or below the 5th percentile level (4th percentile for WOFEC indicated by dotted line in Table VIII*), and then only after "testing the limits"† (4).

DISCUSSION

Previously published normative standards of performance on all subtests of the "rail battery" (7) and on all subtests (except WOFEC) of the "floor battery" (2) were based on the following chronological age groupings: 17-42, 43-50, and 51-53 years. The new chronological age groupings on which the revised normative standards are based tentatively suggest that aging+ negatively influences ataxia test battery performance skills several years earlier than previously reported (2,7); i.e., within the 30-40 rather than 43-50 year age range.

Noteworthy is the finding that amidst great individual differences in the performance scores of the men tested (Tables II-VII) as well as amidst differences in the nature of the complex performance skills sampled by the varied subtests, the magnitude of the negative influences of aging observed on all subtest (except WOFEC) performance scores was very nearly similar (Figure 1). This result implies a reliably unitary sensitivity of the ataxia test battery to aging influences on the complex postural equilibrium functions sampled by it. However, the ultimate reliability of all chronological age group differences in performance scores on this ataxia battery awaits testing of additional samples of comparable individuals (particularly in the 51-60 age group).

A revision of normative standards of ataxia test battery performance scores of samples of women is needed also, particularly for clinical purposes, and awaits availability of larger samples of testees who are comparable to the samples of men tested in terms of medical and physical status. Meanwhile, present revised normative standards based on new chronological age groupings of the maximum number of normal

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* A perfect score of 30 steps was obtained by 96 percent of the standardization group and, therefore, has a 100th-5th percentile equivalent (4).

† This refers to retesting an individual to insure the reliability of 5th percentile or below scores obtained during initial testing.

+ A determination of expected medical and other health-related correlates of aging by data analysis of carefully evaluated variables would undoubtedly throw desirable light on the nature of the observed group differences in terms other than aging per se; e.g., in terms of "physiological aging." Preliminary efforts in this direction have begun (5,6).

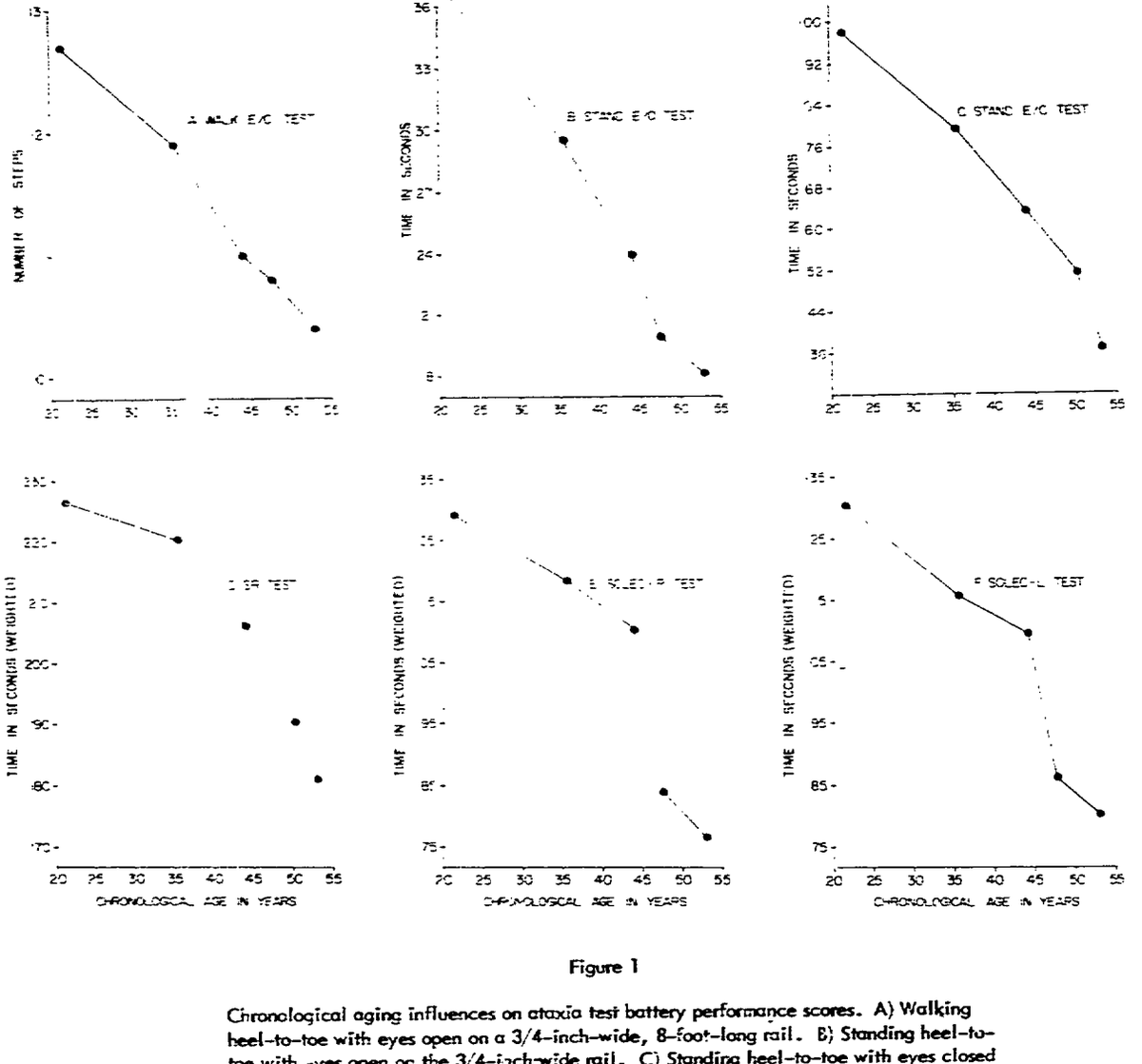

Figure 1

Chronological aging influences on ataxia test battery performance scores. A) Walking heel-to-toe with eyes open on a 3/4-inch-wide, 8-foot-long rail. B) Standing heel-to-toe with eyes open on the 3/4-inch-wide rail. C) Standing heel-to-toe with eyes closed on a 2-1/4-inch-wide, 30-inch-long rail. D) Sharpened Romberg: standing heel-to-toe on the floor with eyes closed. E-F) Stand One Leg Eyes Closed-Right and -Left on the floor.

men tested to date at this laboratory, which are now more nearly similar to the chronological age groupings employed for women--ages 18-29, 30-49, and 50-59 (2,7), should allow greater comparability of the scores of men with those of women, as well as generally more precise application of the test battery in both laboratory and clinical situations. It has proved to be particularly useful in vestibular physiological and neuro-otological assessment of postural equilibrium-disequilibrium, including spontaneous and induced vestibular ataxia (1-4,7). Clinical and/or research applications of the battery in other areas, such as medicine, physiology, pharmacology, gerontology, audiology, and psychology, are recommended.

Table I

Correlation of Ataxia Test Battery Scores with Chronological Ages of Normal Men

Ataxia Test Battery	Ages 16–60 yr N	r	Ages 16–30 yr N	r	Ages 31–40 yr N	r	Ages 41–45 yr N	r	Ages 46–50 yr N	r	Ages 51–60 yr N	r
SR	1055	.297*	547	.031	100	.076	125	.041	241	.044	42	.024
Walk E O	1055	.300*	547	.087	100	.172	125	.078	241	.047	42	.085
Stand E O	1055	.266*	547	.058	100	.186	125	.080	241	.018	42	.014
Stand E C	1055	.363*	547	.098	100	.149	125	.168	241	.082	42	.088
SOLEC-R	749	.413*	488	.061	85	.126	36	.287	105	.029	35	.168
SOLEC-L	749	.408*	488	.039	85	.061	36	.098	105	.100	35	.159

*$p < .001$

Table II

Walk E/O Test: Norms, Means, and Standard Deviations of Scores of Normal Men in Five Age Categories

Percentile	Age Categories 16-30 yr	31-40 yr	41-45 yr	46-50 yr	51-60 yr
99th	15	15	15	15	15
95th	--	--	--	--	--
90th	--	--	--	--	14
85th	--	--	14	14	--
80th	--	--	13	13	13
75th	--	14	--	--	--
70th	--	--	--	--	12
65th	14	--	12	--	11
60th	--	13	--	12	--
55th	--	--	--	--	10
50th	13	--	11	11	--
45th	--	12	--	--	--
40th	--	--	10	10	--
35th	12	11	--	--	9
30th	--	10	--	9	--
25th	11	--	9	--	8
20th	--	--	--	8	--
15th	10	9	8	7	7
10th	9		7	--	--
5th	8	6	6	5	--
4th	7	--	--	--	--
3rd	--	--	--	--	--
2nd	--	4	5	4	4
1st	6	--	--	--	--
Age N	547	100	125	241	42
Mean	21.43	35.52	44.00	47.65	52.98
S.D.	3.24	3.01	1.12	1.36	2.01
Score (Maximum 15 steps)					
Mean	12.69	11.89	11.00	10.83	10.38
S.D.	2.42	2.82	2.66	2.99	2.71

Table III

Stand E/O Test: Norms, Means, and Standard Deviations of Scores of Normal Men in Five Age Categories

	Age Categories				
Percentile	16-30 yr	31-40 yr	41-45 yr	46-50 yr	51-60 yr
99th	166	173	107	76	41
98th	148	143	100	68	39
97th	130	113	79	55	38
96th	118	93	73	49	37
95th	105	78	67	43	36
90th	72	63	45	35	28
85th	53	48	37	27	26
80th	47	37	32	24	25
75th	42	32	29	22	23
70th	38	29	26	21	22
65th	34	27	24	20	21
60th	31	25	22	19	20
55th	29	23	20	18	19
50th	27	21	18	17	18
45th	26	19	17	16	17
40th	24	18	16	15	16
35th	22	17	14	14	15
30th	20	16	13	13	13
25th	19	15	12	12	12
20th	17	13	11	11	11
15th	16	12	10	--	10
10th	14	10	9	10	9
5th	12	9	8	9	8
4th	11	8	--	--	--
3rd	10	--	7	8	--
2nd	9	6	5	--	7
1st	--	5	4	--	5
Age N	547	100	125	241	42
Mean	21.43	35.52	44.00	47.65	52.98
S.D.	3.24	3.01	1.12	1.36	2.01
Score (Maximum 180 seconds)					
Mean	36.35	29.50	23.88	19.90	18.12
S.D.	30.24	28.73	19.47	14.66	7.98

Table IV

Stand E/C Test: Norms, Means, and Standard Deviations of Scores of Normal Men in Five Age Categories

Percentile	Age Categories 16-30 yr	31-40 yr	41-45 yr	46-50 yr	51-60 yr
99th	180	180	180	180	121
98th	--	--	--	--	119
97th	--	--	--	--	102
96th	--	--	179	179	101
95th	--	--	--	165	100
90th	--	179	152	135	82
85th	178	163	131	93	75
80th	163	148	120	75	51
75th	150	127	97	65	44
70th	140	118	72	54	37
65th	127	100	62	48	35
60th	115	78	56	43	33
55th	106	63	47	39	31
50th	92	56	43	34	30
45th	78	49	37	29	28
40th	70	45	34	28	26
35th	62	36	30	25	25
30th	55	32	27	23	23
25th	48	29	24	21	21
20th	43	26	21	20	19
15th	35	23	19	18	17
10th	30	20	17	16	14
5th	22	16	13	14	11
4th	20	15	12	13	10
3rd	18	14	11	--	--
2nd	16	--	10	11	9
1st	14	--	9	10	--
Age N	547	100	125	241	42
Mean	21.43	35.52	44.00	47.65	52.98
S.D.	3.24	3.01	1.12	1.36	2.01
Score (Maximum 180 seconds)					
Mean	98.01	79.29	63.57	51.37	37.50
S.D.	55.32	58.03	51.89	44.84	26.86

Table V

SR Test: Norms, Means, and Standard Deviations of Scores of Normal Men in Five Age Categories

Percentile	Age Categories 16-30 yr	31-40 yr	41-45 yr	46-50 yr	51-60 yr
99th	240	240	240	240	240
95th	--	--	--	--	--
90th	--	--	--	--	--
85th	--	--	--	--	--
80th	--	--	--	--	--
75th	--	--	--	--	--
70th	--	--	--	--	239
65th	--	--	--	--	--
60th	--	--	--	239	238
55th	--	--	--	--	223
50th	--	239	239	238	208
45th	--	--	--	211	198
40th	239	--	238	195	192
35th	--	238	--	187	186
30th	--	--	207	183	146
25th	238	221	191	157	134
20th	228	212	183	143	105
15th	202	205	135	106	76
10th	189	158	92	68	69
5th	161	105	64	39	28
4th	145	95	58	31	27
3rd	134	83	42	26	26
2nd	96	80	35	23	25
1st	55	50	29	17	24
Age N	547	100	125	241	42
Mean	21.43	35.52	44.00	47.65	52.98
S.D.	3.24	3.01	1.12	1.36	2.01
Score (Maximum 240 seconds)					
Mean	226.70	220.33	205.95	190.29	181.00
S.D.	33.95	42.57	59.77	67.36	71.62

Table VI

SOLEC-R Test: Norms, Means, and Standard Deviations of Scores of Normal Men in Five Age Categories

Percentile	Age Categories 16-30 yr	31-40 yr	41-45 yr	46-50 yr	51-60 yr
99th	150	150	150	150	150
95th	--	--	--	--	--
90th	--	--	--	--	149
85th	--	--	--	149	131
80th	--	--	--	138	128
75th	--	--	--	127	114
70th	--	--	149	124	111
65th	--	--	--	117	102
60th	149	149	143	105	90
55th	--	148	145	87	79
50th	148	147	135	77	69
45th	146	140	128	71	58
40th	141	128	115	65	55
35th	133	112	106	49	49
30th	129	100	72	43	44
25th	124	91	65	37	40
20th	115	78	56	34	33
15th	95	62	45	30	29
10th	75	37	39	27	24
5th	54	31	22	23	17
4th	50	30	20	22	16
3rd	44	29	19	20	--
2nd	39	--	17	18	15
1st	34	27	15	11	14
Age N	488	85	36	105	35
Mean	21.25	35.71	43.75	47.83	53.14
S. D.	3.10	2.95	1.42	1.43	2.11
Score (Maximum 150 seconds)					
Mean	129.87	118.39	110.53	83.91	76.77
S. D.	31.68	42.02	46.61	46.93	43.61

Table VII

SOLEC-L Test: Norms, Means, and Standard Deviations of Scores of Normal Men in Five Age Categories

Percentile	Age Categories 16-30 yr	31-40 yr	41-45 yr	46-50 yr	51-60 yr
99th	150	150	150	150	150
95th	--	--	--	--	--
90th	--	--	--	--	149
85th	--	--	--	149	137
80th	--	--	--	140	128
75th	--	--	--	129	123
70th	--	149	149	125	110
65th	--	148	148	118	101
60th	--	145	146	110	95
55th	--	139	141	97	74
50th	149	130	138	84	70
45th	148	127	133	71	67
40th	142	123	125	57	60
35th	133	114	101	52	56
30th	127	100	85	48	45
25th	122	91	65	42	41
20th	113	68	53	38	38
15th	98	60	41	34	34
10th	78	44	22	27	29
5th	56	37	19	22	17
4th	53	35	--	20	16
3rd	42	34	18	18	--
2nd	31	31	12	16	15
1st	24	22	10	13	14
Age N	488	85	36	105	35
Mean	21.25	35.71	43.75	47.83	53.14
S.D.	3.10	2.95	1.42	1.43	2.11
Score (Maximum 150 seconds)					
Mean	130.12	115.55	109.56	86.17	80.26
S.D.	31.70	40.23	48.86	46.69	43.51

Table VIII

WOFEC Test: Norms, Mean, and Standard Deviation of Scores of Normal Men, Ages 17-61 Years

Percentile	Score
99th	30
95th	--
90th	--
85th	--
80th	--
75th	--
70th	--
65th	--
60th	--
55th	--
50th	--
45th	--
40th	--
35th	--
30th	--
25th	--
20th	--
15th	--
10th	--
5th	--
4th	29
3rd	27
2nd	24
1st	17
Age N	287
Mean	24.25
S.D.	8.73
Score (Maximum 30 steps)	
Mean	29.74
S.D.	1.65

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